PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/38 — A1

(11) International Publication Number: WO 96/18277

(43) International Publication Date: 13 June 1996 (13.06.96)

(21) International Application Number: PCT/SE95/01396

(22) International Filing Date: 22 November 1995 (22.11.95)

(30) Priority Data:
9404275-1 8 December 1994 (08.12.94) SE

(71) Applicant *(for all designated States except US)*: TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) [SE/SE]; S-126 25 Stockholm (SE).

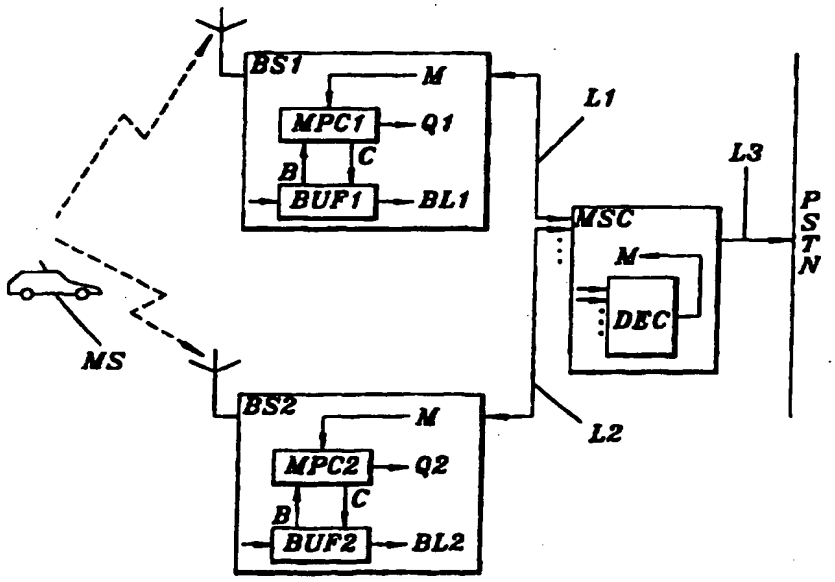
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: CHAMBERT, George [SE/SE]; Hävelvägen 5, S-756 47 Uppsala (SE).

(74) Agents: BJELLMAN, Lennart et al.; Dr Ludwig Brann Patentbyrå AB, P.O. Box 1344, S-751 43 Uppsala (SE).

(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, LS, MW, SD, SZ, UG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: UP LINK MACRO DIVERSITY METHOD AND APPARATUS IN A DIGITAL MOBILE RADIO COMMUNICATION SYSTEM



(57) Abstract

A digital cellular mobile radio communication system comprises a mobile station (MS) transmitting an information block and a set of base stations (BS1, BS2) receiving information blocks (BL1, BL2) corresponding to said transmitted information block at each base station in said set. This communication system contains an up link macro diversity system with means (MPC1, MPC2) in each base station (BS1, BS2) for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2), and decision means (DEC) for choosing the received information block (BL1, BL2) with the best quality measure as a common output information block of said set of base stations (BS1, BS2).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgystan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakhstan
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SI	Slovenia
SK	Slovakia
SN	Senegal
TD	Chad
TG	Togo
TJ	Tajikistan
TT	Trinidad and Tobago
UA	Ukraine
US	United States of America
UZ	Uzbekistan
VN	Viet Nam

UP LINK MACRO DIVERSITY METHOD AND APPARATUS IN A DIGITAL MOBILE RADIO COMMUNICATION SYSTEM

TECHNICAL FIELD

The present invention relates to macro diversity in a digital mobile radio communication system, and in particular to an up link macro diversity method and apparatus in such a system.

BACKGROUND OF THE INVENTION

In conventional digital cellular mobile radio communication systems a mobile station communicates with only one base station at each given time. However, recently it has been suggested to use so called macro diversity in such systems. This concept means that in the down link direction several base stations send the same information blocks to a mobile station, which combines the sent blocks into a final received block. In the up link direction a mobile station transmits an information block which is received at several base stations. The received blocks are transmitted to a common node in the land system, for example a mobile services switching center, where the received blocks are combined into a final received block. These procedures increase the reliability of the received information blocks, since the information has now travelled along different paths, one of which may distort the information less than the other.

A drawback of these up link diversity methods is that the received information blocks from several base stations have to be sent to the mobile services switching center, which reduces the capacity of the land system.

SUMMARY OF THE INVENTION

An object of the present invention is therefore to provide an up link macro diversity method and apparatus in a digital cellular mobile radio communication system in which the capacity of the

land system is increased by reducing the amount of information that has to be transferred between base stations and the next node of the land system of said communication system, for example a mobile services switching center.

One way to combine information blocks from several base stations is to use only the information from the "best" block. In such a case it would be unnecessary to transfer the information of discarded blocks between base stations and the mobile services switching center. Thus, the present invention is based on the idea that instead of transferring all the received blocks, it is sufficient to calculate a quality measure for each block and to transfer only these quality measures. The quality measures received by the mobile services switching center are then compared, and the base station from which the best quality measure was received is ordered to transfer its information block.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

FIGURE 1 is a block diagram of a part of a digital cellular mobile radio communication system illustrating the concepts of the present invention;

FIGURE 2 is a diagram illustrating the signal transfer between base stations and a mobile services switching center operating in accordance with the present invention; and

FIGURE 3 is a flow chart illustrating the method in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with reference to a digital cellular radio communication system of TDMA type. However, the invention is not restricted to such systems, but is also applicable to other digital cellular systems, such as CDMA systems.

In Figure 1 a mobile MS transmits information blocks, which are received at two base stations BS1 and BS2. The received signals are demodulated and decoded in accordance with conventional methods, and the resulting information blocks BL1 and BL2, respectively, are stored in respective buffers BUF1 and BUF2. In a preferred embodiment an information block is a frame, which typically corresponds to 10-40 ms of speech/data. Microprocessor controllers MPC1 and MPC2, respectively, retrieve relevant bits over bit retrieval lines B for calculating and outputting corresponding quality methods Q1 and Q2, respectively, of the stored blocks BL1 and BL2.

Here the concept quality measure does not necessarily mean just a single value, but could imply a sequence of values representing different aspects of the quality of the respective received block.

Examples of suitable quality measures are the number of bytes in a block that contained an error that was correctable, the number of bytes that contain non-correctable errors, or a combination thereof. Another quality measure is described in WO-94/05100, according to which a channel estimate is used to form a quality measure.

The quality measures Q1, Q2 are sent on respective lines L1, L2 to the mobile services switching centers MSC, which contains a decision means DEC that receives these signals. Decision means DEC may for instance comprise a micro processor. The dots below line L2 and below the input lines of decision means DEC imply

that quality measures may be received from more than two base stations. In fact in its most general form the invention implies receiving quality measures Q1, Q2, ..., QN from a set of corresponding base stations BS1, BS2, ..., BSN.

Decision means DEC determines the best received quality measure and sends a message M to the microprocessor controller in the corresponding base station BS1 or BS2 over corresponding line L1 or L2. The microprocessor controller that receives this message, over a line C instructs its buffer to output its block (BL1 or BL2) to mobile services switching center MSC. On the corresponding output line (L1 or L2). The block received by mobile services switching center MSC is considered as the common output block from all the base stations in the set.

The above procedure is further illustrated in Figure 2. Here quality measures Q1 and Q2 are received by mobile services switching center MSC from the base stations BS1 and BS2, respectively. The decision means in mobile services switching center MSC determines that Q2 is the best measure, which implies that block BL2 is the most reliable block. Therefore mobile service switching center MSC sends message M to base station BS2, in which microprocessor controller MPC2 instructs buffer BUF2 to output block 2 to mobile services switching center MSC, which in turn outputs block BL2 on line L3 to the public switched telephone network PSTN (see Figure 1) as a common output from base stations BS1, BS2.

In the above description it has been assumed that lines L1, L2 are used for signalling (Q1, Q2, M) as well as information transfer (BL1, BL2). However, in practice there may be separate lines for signalling and information transfer.

Figure 3 is a flow chart illustrating the above described method. The routine starts in step 300. In step 310 the measures Q1, Q2, ..., QN of the received information blocks are calculated at each base station BS1, BS2, ..., BSN in the set. In step 320 the set

of quality measures Q1, Q2, ..., QN are sent to decision means DEC. In step 330 decision means DEC determines the best measure Q. In step 340 the base station that corresponds to the block with the best Q is instructed to output its block as a common output from the entire set of base stations. Finally the routine ends in step 350. This routine is repeated for each information block that is transmitted from the mobile station MS and received by the base stations in the set.

In the above described embodiment it has been assumed that decision means DEC is located in a mobile services switching center. However, this is not necessarily the case, since decision means DEC does not actually process any received information blocks, it only receives quality measures, determines the best measure and instructs a corresponding base stations to output its block. Therefore decision means DEC may be physically separated from mobile services switching center MSC. However, the actually transferred information blocks from base stations BS1, BS2 will be sent to mobile services switching center MSC.

In the above description it has also been assumed that only one information block is chosen from a set of received information blocks. However, it is within the scope of the same inventive idea to form (in element DEC in Fig. 1, for example) a combination of the best (in terms of quality measure) received blocks as a common output from a set of base stations. This would still reduce the amount of signaling, since not all received blocks have to be transferred to the mobile services switching center. For example, if the 3 best received blocks are transferred to the mobile services switching center, a combined block may be formed by setting each bit in this block equal to the value of the majority of the 3 corresponding transferred bits.

Furthermore, in this specification the present invention has been described with reference to a TDMA system. However, as noted above the invention is also applicable to a CDMA system.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the spirit and scope thereof, which is defined by the appended claims.

CLAIMS

1. An up link macro diversity method in a digital cellular mobile radio communication system, comprising the steps of transmitting an information block from a mobile station and receiving information blocks corresponding to said transmitted information block at each base station of a predetermined set of base stations, said method being characterized by the further steps of:

determining, at each base station in said set, a quality measure representing the reliability of each respective received information block;

choosing the information block with the best quality measure as a common output information block of said set of base stations.

2. The method of claim 1, characterized by the further steps of:

sending the quality measure from each base station to a decision means;

determining the best quality measure in said decision means; and

ordering the base station corresponding to the best quality measure to output its received information block as said common output information block.

3. An up link macro diversity method in a digital cellular mobile radio communication system, comprising the steps of transmitting an information block from a mobile station and receiving information blocks corresponding to said transmitted information block at each base station of a predetermined set of base stations, said method being characterized by the further steps of:

determining, at each base station in said set, a quality measure representing the reliability of each respective received information block;

combining some received information blocks having the best quality measures into a common output information block of said

set of base stations.

4. An up link macro diversity system in a digital cellular mobile radio communication system, comprising a mobile station transmitting an information block and a set of base stations receiving information blocks corresponding to said transmitted information block at each base station in said set, said diversity system being characterized by:

means (MPC1, MPC2) in each base station (BS1, BS2) of said set for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2);

decision means (DEC) for choosing the received information block (BL1, BL2) with the best quality measure as a common output information block of said set of base stations (BS1, BS2).

5. The diversity system of claim 4, characterized by said decision means (DEC) being connected to each base station (BS1, BS2) in said set for receiving said quality measures, determining the best quality measure and ordering the base station corresponding to the best quality measure to output its received information block as said common output information block.

6. The diversity system of claim 6, characterized by said decision means (DEC) being provided in a mobile services switching center (MSC).

7. An up link macro diversity system in a digital cellular mobile radio communication system, comprising a mobile station transmitting an information block and a set of base stations receiving information blocks corresponding to said transmitted information block at each base station in said set, said diversity system being characterized by:

means (MPC1, MPC2) in each base station (BS1, BS2) of said set for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2);

means (DEC) for combining some received information blocks (BL1, BL2) having the best quality measures into a common output information block of said set of base stations (BS1, BS2).

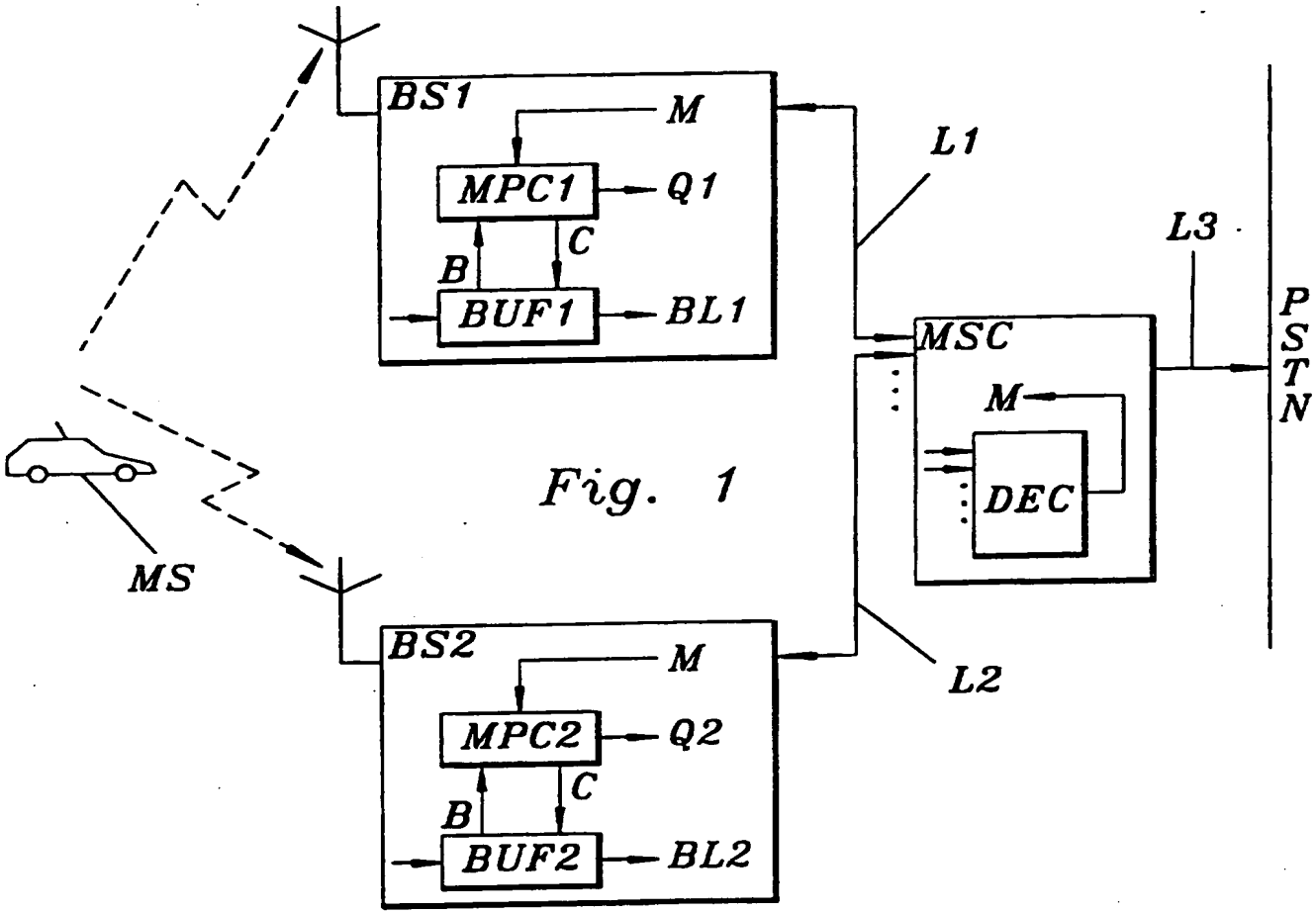

BS1
M
MPC1
Q1
C
B
BUF1
BL1
L1
L3
MSC
M
DEC
PSTN
MS
BS2
M
MPC2
Q2
C
B
BUF2
BL2
L2

Fig. 1

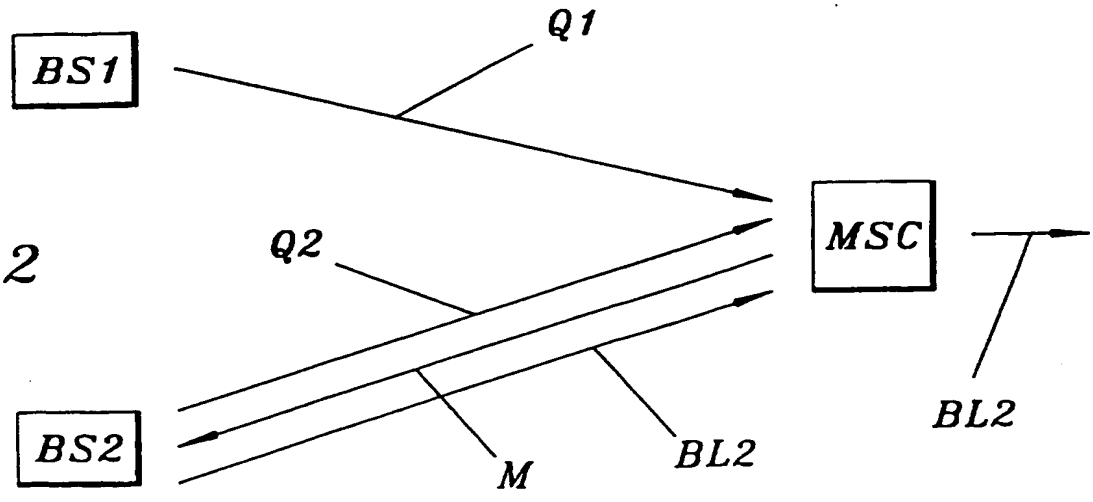

BS1
Q1
MSC
Q2
BS2
M
BL2
BL2

Fig. 2

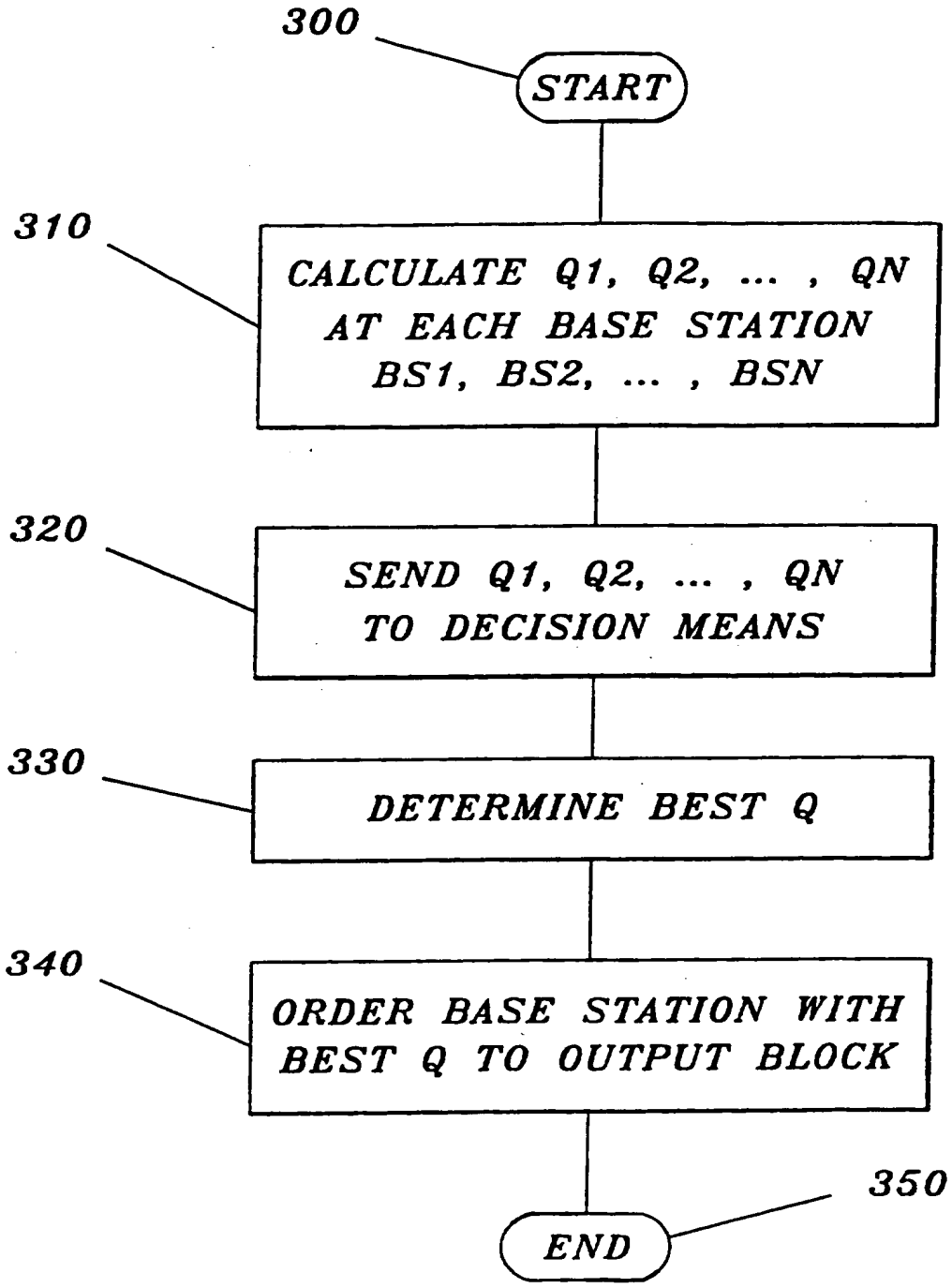


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/01396

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 9504419 A1 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY), 9 February 1995 (09.02.95), page 1, line 35 - page 2, line 37; page 5, line 29 - line 34; page 8, line 8 - line 9, page 8, line 32 - line 35	1-7
A,P	EP 0643542 A1 (SIEMENS AKTIENGESELLSCHAFT), 15 March 1995 (15.03.95), see whole document	1-7
A	WO 9319537 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 30 Sept 1993 (30.09.93), page 8, line 27 - page 9, line 8; page 15, line 4 - line 21; page 17, line 1 - line 10	1-7

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 March 1996	02 -04- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Peter Hedman Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

05/02/96

International application No.
PCT/SE 95/01396

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A1- 9504419	09/02/95	NONE		
EP-A1- 0643542	15/03/95	NONE		
WO-A1- 9319537	30/09/93	AU-B-	659308	11/05/95
		AU-A-	3910893	21/10/93
		BR-A-	9305449	11/10/94
		CA-A-	2109114	25/09/93
		EP-A-	0586681	16/03/94
		FI-D-	935194	00/00/00
		JP-T-	6508492	22/09/94
		NZ-A-	251478	21/12/95